US Army Corps of Engineers®
Baltimore District

Water Quality Standard Operating Procedures

U.S. Army Corps of Engineers, Baltimore District

Engineering Division

Civil Works Branch

Water Management Section

01 April 2026

SOP Signature Page

Engineering Division

X PEDRICK.SARAH.DRU.1454395715 Digitally signed by PEDRICK.SARAH.DRU.1454395715 Date: 2026.04.02 17:09:06 -04'00'

Sarah Pedrick, Author
Water Quality Program Manager

X MAI.SANDY.1506194810 Digitally signed by MAI.SANDY.1506194810 Date: 2026.04.03 08:30:52 -04'00'

Sandy Mai, Reviewer
Engineer, Water Management Section

X FRITZ.JULIA.A.1229344800 Digitally signed by FRITZ.JULIA.A.1229344800 Date: 2026.04.07 15:46:57 -04'00'

Julia Fritz
Chief, Water Management Section

X FEDOR.BENJAMIN.A.1256602721 Digitally signed by FEDOR.BENJAMIN.A.1256602721 Date: 2026.04.16 11:14:45 -04'00'

Benjamin Fedor
Chief, Civil Works Branch

Operations Division

X BROWN.STEVEN.MICHAEL.1040446237 Digitally signed by BROWN.STEVEN.MICHAEL.1040446237 Date: 2026.04.16 09:25:51 -04'00'

Steven Brown
Chief, Flood Risk Management Branch

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Introduction

Water quality management requirements for the United States Army Corps of Engineers (USACE), Baltimore District (NAB) are derived from the Federal Water Pollution Control Act of 1948 and its amendments including the Clean Water Act of 1977 and the Water Quality Act of 1987. The USACE maintains environmental management responsibilities outlined in the Water Resources Development Act (WRDA), its amendments, and the USACE Environmental Operating Principles (EOPs). Together, these Acts affirm Federal interest in water quality and environmental management activities. Guidance for developing and maintaining an effective water quality sampling program is provided by USACE ER 1110-2-8154 Water Quality Management. The Water Quality Team (WQT) is a component of the Water Management Section within NAB; it utilizes a multidisciplinary approach to assess various environmental issues associated with project operations. The WQT's mission objectives include:

1. Monitor and assess water quality conditions in the tailwater, reservoir, and significant tributaries of each project.
2. Support Water Management operations while striving to meet USACE Environmental Operating Principles.
3. Evaluate annual water quality data for comparison to historical trends, as well as State and Federal regulations.
4. Assess effectiveness of Water Control plans, where applicable, to manage for water quality concerns.

These objectives are accomplished by using physical, chemical, and biological indicators to support the effective operation of NAB Projects for their authorized purposes while maintaining environmental integrity of those resources.

This document covers procedures and activities related to the collection of water quality data in streams and reservoirs within NAB. The methods and actions herein are applicable to sampling personnel within the Water Management Section of the Engineering Division – Civil Works Branch. This document has been developed to codify existing sampling activities and to provide flexibility for any additions in the future. Activities covered under this document include procedures related to boat operation, travel, site collection of data, data entry, data archival/curation, and Quality Assurance/Quality Control.

Water Quality Assessment Qualifications and Safety Requirements

Activities described within this document can be conducted from a boat, shorelines, or instream wading.

Personnel Qualifications

Any personnel that operate a vessel pursuant to sampling activities must have successfully completed the USACE Boat Operators Course and have a reasonable amount of experience in operating boats on reservoirs and/or rivers. The USACE Boat Operators Course requires the ability to swim and has training required for open water rescue. Recertification of the Boat Operators License is required every 5 years. Exceptions may be made for personnel working towards obtaining their USACE Boat Operator License, but these personnel must be under the direct supervision of a certified Water Quality Team member. Prior to any coworker training, the personnel must have or obtain a State Boating License. At this time,

personnel can obtain their MD State Boating license for free, PA for $10, and NY for $15. A State license is required for the USACE Boat Operators Course.

Benthic macroinvertebrate collection may only be conducted with appropriate permits from the States of Maryland, New York, Pennsylvania, and West Virginia. The permit holder must be present during collection. Any personnel participating in macroinvertebrate collection must either have a collection permit or be listed as an assistant under the permit holder conducting collection. All personnel must abide by the terms and conditions of the collection permit(s). Anyone collecting in Pennsylvania is required to have a fishing license; this is a reimbursable expense.

Health and Safety

All personnel must familiarize themselves and abide by EM 385-1-1. Risks associated with water quality sampling activities include, but are not limited to, slips/trips/falls, chemical spills, and falling overboard. Continuous use of personal protective equipment (PPE) while conducting activities will provide a safeguard for potential health and safety issues.

When processing water samples from each collection point, wearing disposable latex or nitrile gloves is recommended to reduce potential sample contamination and to offer protection from sample reagents and preservatives (if used).

Reservoir sampling activities require wearing personal floatation devices (PFDs). Personnel will ensure towing vehicle and trailer safety by conducting an inspection prior to departure; the inspection includes, but is not limited to, ensuring the boat is properly attached to the trailed, tires have adequate pressure, and all lights are functional. Towing vehicle and boat fuel tanks will be filled before proceeding to the site, and spare fuel tank(s) should always be carried while boating. Prior to launching the boat, unplug trailer lights from truck, detach straps from vessel, unlock outboard motors, and install bow and bilge/transom plugs. A minimum of two personnel will launch the vessel, which includes backing the boat into the water, removing the bow strap, and disengaging from the trailer. Waders should never be worn aboard a vessel. If personnel wish to remain dry while conducting boat sampling activities, a rain suit, in conjunction with a PFD, can be worn. All navigation standards set by the U.S. Coast Guard should be followed during boat operation.

Personal Protective Equipment and Supplies

Boat and Inflow/Tailwater PPE

1. PFD
2. Drinking water
3. First aid kit
4. Sunblock
5. A sturdy pair of closed-toe shoes
6. Nitrile/latex gloves

Inflow/Tailwater and Benthic Macroinvertebrate Only PPE

1. Waders or closed-toe shoes

Laboratory Analysis PPE

1. Full-length pants
2. Closed-toe shoes

3. Nitrile/latex gloves
4. Eye protection

General Water Quality Assessment Trips

Biological, chemical, and physical parameters are generally collected on all full sampling trips. The exception to this is benthic macroinvertebrate sampling, which will be described in a separate section further in this document.

Equipment and Supplies

Water Quality personnel must ensure all equipment is calibrated and the equipment and supplies are loaded into the towing vehicle prior to departure from the Fort McHenry Field Office. Equipment is to be calibrated per manufacturer recommendation or as required, should performance deviations occur, whichever is sooner. YSI EXO2 calibration instructions are located at https://www.ysi.com/exo-university.

Boat and Inflow/Tailwater

1. PPE
2. Deionized Water
3. 1L polyethylene (PET) bottles
4. Phenolphthalein
5. Bromocresol Green/Red Indicator Solution
6. Sodium Hydroxide Standard Solution
7. Sulfuric Acid Standard Solution
8. Hardness Reagent Set
    - CalVer 2 Calcium Indicator Powder Pillows
    - Potassium Hydroxide Standard Solution, 8 N
    - TitraVer Hardness Titrant, 0.020 N
9. TitraVer Hardness Titrant, 0.2000 N
10. Three 50mL Class A Burets
11. Two Buret Double Clamps
12. Two Buret Stands
13. Funnel
14. Two 250mL flasks
15. 50mL Graduated Cylinders
16. Sharpies
17. Pencils
18. WQ Data Collection Equipment
    - YSI EXO2, Handheld, and cables
19. NAB WQ Field Sheets
20. Emergency Equipment including, but not limited to throw rope, throw ring, and rescue hook
21. Cooler(s) with ice
22. Material Safety Datasheets

Boat Only

1. Kemmerer Bottle
2. Secchi Disk

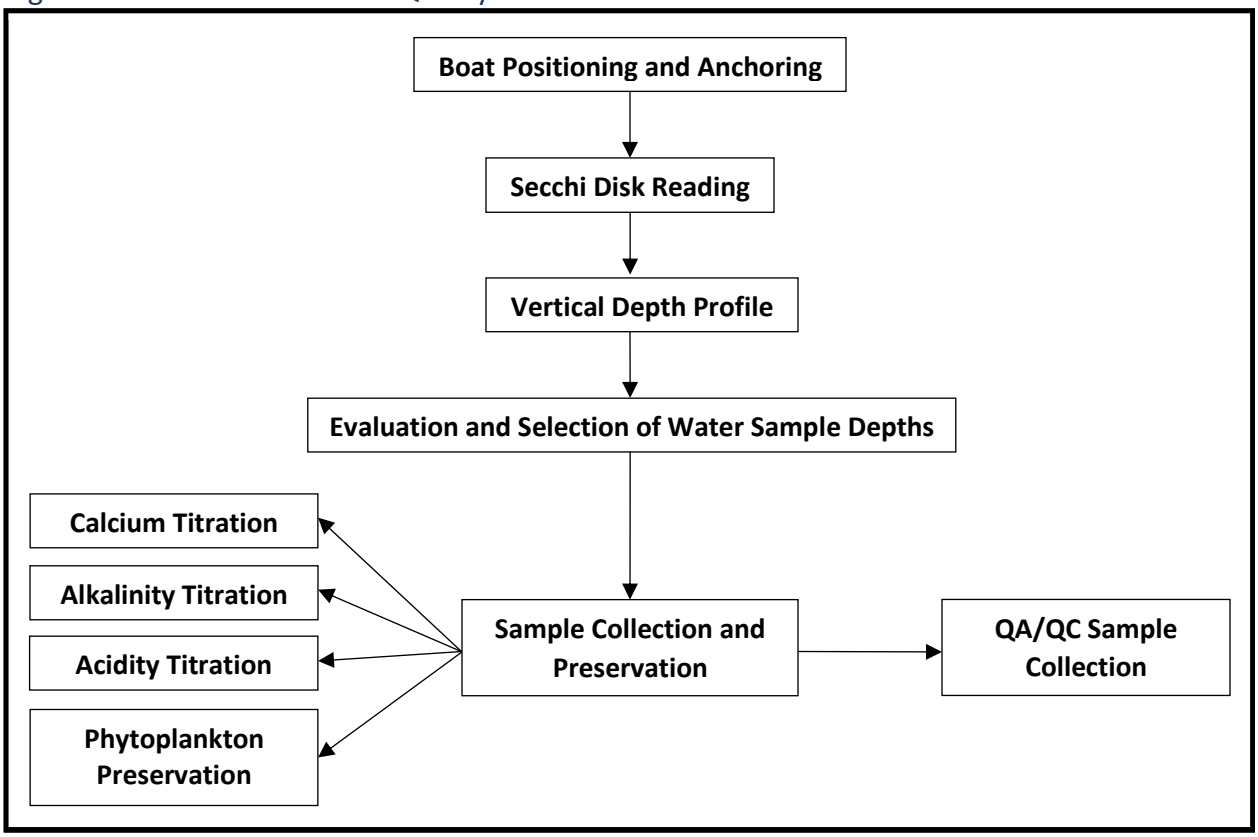
3. 1% w/v Lugol Solution
4. 500mL Bottles
5. Maintained vessel with anchor and spare fuel

Project Station Locations

NAB sampling locations have been established as fixed stations, which can be navigated to using chart plotters, GPS units, and/or navigation charts. All stations are identified in NAB's Water Quality Program Management Plan. Historic station and data information are stored in DASLER and shall only be accessed by qualified personnel.

Boating Sampling Procedures

Figure 1: Flowchart for Water Quality Assessments in Reservoirs



Water Quality Field Sampling Procedures - Reservoirs

Boat Positioning and Anchoring

Once at a station, boat operator should move the vessel to channel center, and then begin to slowly troll towards the shoreline. During this maneuver the operator should be examining the depth finder to locate the thalweg. This may involve driving past it and then turning around and coming back to the actual location. The boat operator should then face the vessel into the wind and perpendicular to waves. The boat operator will then put the engine in neutral and a second crew member will deploy the anchor upon instruction from the boat operator. In situations where there is minimal wind, a station profile can be taken by drifting with the current along the thalweg. In situations where there is strong current and the anchor will not hold, the boat operator may need to make multiple adjustments while the second crew

member takes a Secchi reading, profile, and water samples. The boat operator and crew member will use caution and continually communicate to ensure any lines and cables do not go under the vessel or near the engine while the engine is in gear.

Secchi Disk Reading

Water clarity is determined with the use of a Secchi disk profile. Secchi measurements are an instantaneous visual estimate of the depth of water clarity, which provides a partial measure of the extent of the photic zone. NAB uses a Secchi disk which is permanently attached to a tape measure.

The visual estimate will be taken on the sunny side of the vessel in the stern area, either starboard or port; midday measurements will be taken in the best area to minimize shadows in the sampling area. This data is recorded on the NAB Water Quality Field Sheet (Appendix A).

To determine Secchi depth, lower the disk into the water until it disappears in the water column. It may be necessary to wind the reel up and down a few times to get perspective on exactly when it disappears. Look for the white section, and reel back in until the white face just appears. Record the depth measurement in meters.

Vertical Depth Profile

NAB utilizes a YSI EXO2 to collect data. The following parameters are typically measured: water temperature, dissolved oxygen, specific conductance, and pH. Standard header information (station, date, time, etc.) and the data results will be entered on the NAB WQ Field Sheet. These measurements help to describe instantaneous water quality conditions at various depths which change throughout the year.

Water quality profiles are vertical measurements taken in 5-foot increments, starting just below the surface, and descending to near bottom. At the first station sampled of the day, the depth sensor of the sonde should be checked for accuracy and calibrated if necessary. The deepest station depth is determined by examining the vessel's depth finder with the deepest profile measurement taken a minimum of one foot from the bottom of the water body; this can be found by gently 'feeling' the bottom and pulling the sonde up. The sonde should be given a moment to stabilize prior to recording data from the lowermost point, as there is the potential for sediment to become mobilized which could skew results.

Evaluation and Selection of Water Sample Depths

Water samples are generally taken at the surface and near bottom. Discretion is used to collect additional samples in the water column at depths where physical and chemical parameters significantly change. Once depths have been determined, water chemistry samples are collected using a vertical Kemmerer. Water samples are placed in appropriate bottles as described below.

Sample Collection for Lab and Field Analysis

Samples may be collected at the surface, near bottom, and/or middle of the profile. Maximum samples per station are indicated in the annual sampling plan. Modifications to water sample depths may be determined by the best judgement of the WQT. For a list of parameters collected by NAB Water Management as part of regular monitoring activities see Appendix D. Water samples for lab and field analysis are collected via a Kemmerer bottle. A 1L bottle is filled for chemical analyses conducted later at the lab, and graduated cylinders and/or flasks are filled for samples analyzed in the field. A 500mL bottle is filled for phytoplankton analysis.

Collection procedure is as follows:

1. Set Up
    a. Prior to any water collection, label all collection bottles with standard information:
        i. Station
        ii. Date
        iii. Time
        iv. Depth
    b. Graduated Cylinders and Flasks
        i. Inspect the glassware for cleanliness, integrity, and function.
        ii. Rinse the glassware thoroughly with deionized water.
    c. Kemmerer bottle
        i. Inspect the Kemmerer bottle for cleanliness, integrity, and function.
        ii. Rinse the bottle thoroughly with deionized water.
        iii. Ensure both end caps are cocked open, and the trip mechanism is properly engaged.
2. Collection
    a. Slowly lower the Kemmerer bottle to the target depth.
    b. Once at target depth, release the messenger down the line, and wait until you feel the Kemmerer close.
    c. Pull the Kemmerer up without jerking the line.
    d. Once at the surface, do not let the line slack, or the Kemmerer will empty, and the sample will need to be reacquired.
3. Lab Sample Preservation and Storage
    a. Chemical Samples
        i. Pour the collected water into the labeled 1L bottle, utilizing the bottom draw, and ensure there is no headspace when securing the cap.
        ii. Place bottle in cooler upright and buried in ice.
    b. Phytoplankton Samples Preservation and Storage
        i. Dose bottle with 10 mL 1% w/v Lugol solution.
        ii. Fill directly from the Kemmerer bottle to just below the neck.
        iii. Store sample at ambient temperature until processing.
4. Field Analysis
    a. Rinse the graduated cylinder and/or flask being utilized for titrations.
    b. Pour sample water from the Kemmerer into the graduated cylinder or flask utilizing the quantity designated in the methods listed below.
    c. Alkalinity
        i. Follow HACH Method 8221: Buret Titration located in the Chemical Analysis Binder.
            1. All NAB samples should fall between the 1-500mg/L range and require a sample volume of 50mL.
        ii. Record Phenolphthalein Alkalinity and Total Alkalinity on the field sheet.
    d. Acidity
        i. Follow HACH Method 8010: Buret Titration located in the Chemical Analysis Binder.

1. All NAB samples should fall between the 1-1000mg/L range and require a sample volume of 50mL.

ii. Record Total Acidity on the field sheet.

e. Calcium

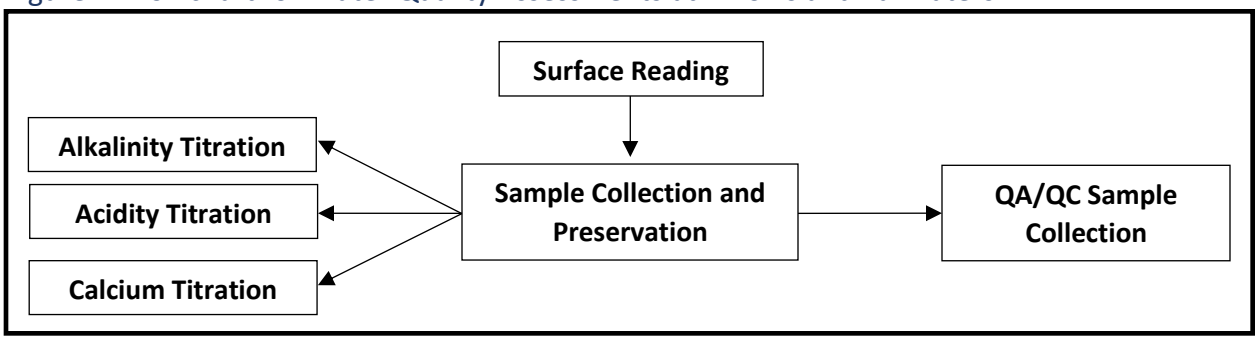
i. Follow HACH Method 8222: Buret Titration located in the Chemical Analysis Binder.

1. All NAB samples should fall between the 0-500mg/L range and require a sample volume of 50mL.

ii. Record Total Calcium on the field sheet.

Inflow and Tailwaters Procedures

Figure 2: Flowchart for Water Quality Assessments at Inflows and Tailwaters



Water Quality Field Sampling Procedures – Inflows and Tailwaters

Surface Reading

NAB utilizes a YSI EXO2 to collect data. The following are parameters typically measured: water temperature, dissolved oxygen, specific conductance, and pH. Standard header information (station, date, time, etc.) and the data results will be entered on the NAB WQ Field Sheet. These measurements help to describe instantaneous water quality conditions at near surface depth which change throughout the year. All near surface data will be recorded at '0' depth. This is imperative for data management.

Water quality measurements are taken just below the surface, in free-flowing water; eddies must be avoided. The sonde should be given a moment to stabilize prior to recording data, as there is the potential for sediment to become mobilized.

Sample Collection for Lab and Field Analysis

Samples are collected at the surface only. Water samples for lab and field analysis are collected from the bank or wading slightly into the water. Samples must be taken upstream of where personnel have disrupted the streambed. Two 1L bottles are filled; one for lab analysis and one for field analysis.

Collection procedure is as follows:

1. Set Up

a. Prior to any water collection, label two 1L water bottles with standard information:

i. Station

ii. Date

iii. Time

iv. Depth

b. Graduated Cylinders and Flasks
    i. Inspect the glassware for cleanliness, integrity, and function.
    ii. Rinse the glassware thoroughly with deionized water.

2. Collection
    a. Locate an area in flowing water that is deep enough to collect a sample without stirring up the bottom.
    b. Ensure collection of samples is upstream of any disturbances, including where you walked through.
    c. Dip the labeled 1L bottles just below the surface, and fill them to the brim ensuring no headspace when securing the cap.
3. Lab Sample Preservation and Storage
    a. Place one bottle in cooler upright and buried in ice.
4. Field Analysis
    a. Rinse the graduated cylinder and/or flask being utilized for titrations.
    b. Pour sample water from the second 1L bottle into the graduated cylinder or flask utilizing the quantity designated in the methods listed below.
    c. Alkalinity
        i. Follow HACH Method 8221: Buret Titration located in the Chemical Analysis Binder.
            1. All NAB samples should fall between the 1-500mg/L as CaCO3 range and require a sample volume of 50mL.
        ii. Record Phenolphthalein Alkalinity and Total Alkalinity on the field sheet.
    d. Acidity
        i. Follow HACH Method 8010: Buret Titration located in the Chemical Analysis Binder.
            1. All NAB samples should fall between the 1-1000mg/L as CaCO3 range and require a sample volume of 50mL.
        ii. Record Total Acidity on the field sheet.
    e. Calcium
        i. Follow HACH Method 8222: Buret Titration located in the Chemical Analysis Binder.
            1. All NAB samples should fall between the 0-500mg/L as CaCO3range and require a sample volume of 50mL.
        ii. Record Total Calcium on the field sheet.

Laboratory Procedures

Upon return to the lab, water chemistry samples will immediately be processed or placed into a commercial refrigerator for analysis the next day. Samples must be analyzed within the hold times identified in the appropriate parameter methodologies contained in the Chemical Analysis Binder. If hold times are not met, samples may not be analyzed. If samples are analyzed, it is imperative to annotate hold times were not met on the field sheets, as well as properly code them in DASLER. It is important to note that the WQ Program is undergoing reevaluation of methods and sample analysis.

Chemical Analyses

Appropriate PPE must be worn. This includes full-length pants, closed-toe shoes, nitrile gloves, and eye protection.

1. Ammonia
    a. Follow HACH Method 10227: TNTplus located in the Chemical Analysis Binder.
        i. Ensure any samples falling below or above detection limits are recorded as "<0.015mg/L" or ">2.0mg/L". DO NOT record spectrophotometer outputs below or above the detection limits.
2. Nitrate
    a. Follow HACH Method 10206: TNTplus located in the Chemical Analysis Binder.
        i. Ensure any samples falling below or above detection limits are recorded as "<0.23mg/L" or ">13.5mg/L". DO NOT record spectrophotometer outputs below or above the detection limits.
3. Orthophosphate
    a. Follow HACH Method 10227: TNTplus located in the Chemical Analysis Binder.
        i. Ensure any samples falling below or above detection limits are recorded as "<0.02mg/L" or ">2.5mg/L". DO NOT record spectrophotometer outputs below or above the detection limits.
4. Sulfate
    a. Follow HACH Method 10227: TNTplus located in the Chemical Analysis Binder.
        i. Ensure any samples falling below or above detection limits are recorded as "<40mg/L" or ">150mg/L". DO NOT record spectrophotometer outputs below or above the detection limits.
5. Iron
    a. Follow HACH Method 10229: TNTplus located in the Chemical Analysis Binder.
        i. Ensure any samples falling below or above detection limits are recorded as "<0.2mg/L" or ">6.0mg/L". DO NOT record spectrophotometer outputs below or above the detection limits.

Benthic Macroinvertebrate Sampling

Qualitative macroinvertebrate samples using D-Frame kick nets are collected at inflows and tailwater stations. NAB follows slightly modified sampling procedures outlined by New York and Pennsylvania sampling protocols. Contractors provide associated metrics for each state.

***For Cowanesque, an interstate project, Pennsylvania sampling protocol will be utilized to maintain consistency for data management and analysis.

Permits

Prior to conducting any sampling, permits must be obtained from the states where sampling will occur. Currently NAB is only collecting in New York and Pennsylvania. All permit requirements must be met prior to, during, and after sampling.

Equipment and Supplies

1. PPE, listed in the Health and Safety Section
2. Deionized Water
3. Pencil
4. Packing tape
5. WQ Data Collection Equipment
    - YSI EXO2, Handheld, and cables
6. Emergency Equipment including, but not limited to throw rope, throw ring, and rescue hook
7. Cooler(s)
8. Material Safety Datasheets
9. D-frame Kick Net (600 µm)
10. Field gloves
11. Sample preservative (field fixing in either 10% formalin or 95% ethanol)
12. Blunt forceps
13. White pans for processing
14. Brass sieve, No. 30
15. Leak-proof Jars, various sizes (500 mL and up)
16. Plastic cup (for backwashing net)
17. NAB WQ Field Sheets
18. Container labels
19. Habitat Assessment Field Sheets
20. Chain of Custody (COC) forms
21. Equipment and Supplies

Sampling Procedures

All States

Physical Chemistry and Surface Reading

NAB utilizes a YSI EXO2 to collect data. The following are parameters typically measured: water temperature, dissolved oxygen, specific conductance, and pH. Standard header information (station, date, time, etc.) and the data results will be entered on the NAB WQ Field Sheet. These measurements help to describe instantaneous water quality conditions at near surface depth which change throughout the year. All near surface data will be recorded at '0' depth. This is imperative for data management.

Water quality measurements are taken just below the surface, in free-flowing water; eddies must be avoided. The sonde should be given a moment to stabilize prior to recording data, as there is the potential for sediment to become mobilized.

Habitat Assessment

Utilizing USEPA's Rapid Bioassessment Protocols, personnel will complete the Habitat Assessment Field Sheet (Appendix E).

New York

Sampling will be conducted by following protocol outlined in *NYDEC SOP: Biological Monitoring of Surface Waters in New York State.*

1. Utilizing a D-Frame net, one person, facing downstream and holding the net firmly on the stream bottom, employs the net. Sampling is continued for 5 minutes for 5 meters. The preferred line of sampling is a diagonal transect of the stream. Larger rocks, sticks, and plants may be removed from the sample if organisms are first removed from them. The net is thoroughly cleaned before further sampling by vigorous rinsing in the stream.
2. Using a pencil, fill out two labels that include the station, date, and time. Place one label in the container and tape the other to the outside. Do not use a pen for labeling; ink will dissolve in ethanol.
3. Submerge the sample in preservative, place the lid on the container, then gently swirl several times.
4. Fill out the COC form.
5. Prior to leaving the sampling site, equipment should be thoroughly rinsed to minimize potential contamination between sites. Mud or debris should be rinsed from boots to the best extent possible.

Pennsylvania

Sampling will be conducted by following protocol outlined in *A Benthic Macroinvertebrate Index of Biotic Integrity for Wadeable Freestone Riffle-Run Streams in Pennsylvania.*

1. Utilizing a D-Frame net, one person, facing downstream and holding the net firmly on the stream bottom, employs the net. One "D-frame effort" is defined as such: the investigator vigorously kicks an approximate area of $1m^2$ immediately upstream of the net to a depth of 4", for approximately one minute. All benthic dislodgement and substrate scrubbing should be done by kicks only. Substrate handling should be limited to only moving large rocks or debris (as needed) with no hand washing. Since the width of the kick area is wider than the net opening, net placement is critical to assure all kicked material flows toward the net. Avoiding areas with crosscurrents, the substrate material from within the area should be kicked toward the center of the area – above the net opening. The amount of effort expended in collecting each sample should be approximately equivalent to make valid comparisons. The effort, expressed as area, must be reported for all collections. Collect a minimum of four screens at each station.
2. Using a pencil, fill out two labels that include the station, date, and time. Place one label in the container and tape the other to the outside. Do not use a pen for labeling; ink will dissolve in ethanol.
3. Submerge the sample in preservative, place the lid on the container, then gently swirl several times.
4. Fill out the COC form.
5. Prior to leaving the sampling site, equipment should be thoroughly rinsed to minimize potential contamination between sites. Mud or debris should be rinsed from boots to the best extent possible.

Laboratory Procedures

Upon return to the lab, personnel will arrange shipping to the appropriate lab for analysis. In preparation, all bottles will be wrapped with parafilm at the lids and packaging material will be utilized to minimize bottle shifting during transport.

Zebra Mussel Sampling

Qualitative and quantitative sampling for zebra mussels is conducted at projects within NAB.

Permits

Prior to conducting any sampling, scientific collection permits must be obtained from the states where sampling will occur. Currently, NAB is only collecting samples in New York, Pennsylvania, and West Virginia. Sampling may occur in Maryland if additional sampling stations are added at Jennings Randolph. All permit requirements must be met prior to, during, and after sampling.

Equipment and Supplies

All Trips

1. PPE, listed under the Health and Safety Section
2. Deionized Water
3. 1L polyethylene (PET) bottles
4. Phenolphthalein
5. Bromocresol Green/Red Indicator Solution
6. Sodium Hydroxide Standard Solution
7. Sulfuric Acid Standard Solution
8. Hardness Reagent Set
    - CalVer 2 Calcium Indicator Powder Pillows
    - Potassium Hydroxide Standard Solution, 8 N
    - TitraVer Hardness Titrant, 0.020 N
9. TitraVer Hardness Titrant, 0.2000 N
10. Three 50mL Class A Burets
11. Two Buret Double Clamps
12. Two Buret Stands
13. Funnel
14. Two 250mL flasks
15. 50mL Graduated Cylinders
16. Sharpie
17. WQ Data Collection Equipment
    - YSI EXO2, Handheld, and cables
18. NAB WQ Zebra Mussel Field Sheets (Appendix B)
19. Emergency Equipment including, but not limited to throw rope, throw ring, and rescue hook
20. Cooler(s) with ice
21. Material Safety Datasheets
22. Kemmerer Bottle
23. Secchi Disk
24. Maintained vessel with anchor and spare fuel

Veliger Sampling

1. Plankton Net (50 µm)
2. Tow Rope
3. 99.5% Ethanol
4. Baking Soda

5. 1L polyethylene (PET) bottles
6. Cooler with Ice

Plate Sampling

Deployment:

1. Plate(s)
2. Buoy(s)
3. Anchor(s)
4. Line(s)
5. Wrenches

Retrieval:

1. 5-gallon Bucket(s)
2. Work Gloves
3. Quart Zip-Lock Bags
4. Gallon Zip-Lock Bags
5. 99.5% Ethanol
6. Putty Knife
7. Wrenches
8. Water Quality Zebra Mussel Field Sheets

Analysis

1. Stereomicroscope with cross-polarization
2. Gridded glass petri dishes
3. 99.5% Ethanol
4. Squirt Bottle
5. Tally Counters
6. Leak-proof Jars
7. Gridded Processing Pans
8. Forceps
9. Razor Blades
10. Samples
11. Water Quality Zebra Mussel Field Sheets

Station Locations

Fixed stations at each project are identified in NAB's Water Quality Program Management Plan. Information regarding specific sampling type (general WQ, veliger, plate, shoreline) at each station is also included in this document.

Procedures

All Stations Sampled

Biological, chemical, and physical parameters are collected on all trips. Procedures for collection are in the *General Water Quality Assessment Trips* section of this document.

Shoreline Stations

Targeted monitoring is typically conducted three to five weeks after water temperature is above 12°C and approximately two months after temperatures are no longer conducive to spawning. Project staff will visit stations no less than once a month.

Survey procedure is as follows:

1. Examine rocks, wood, vegetation, docks, buoys, and other debris. When necessary, retrieve substrates slowly for closer examination.
    a. Pick up the rocks, they are tiny can be small and feel like sand.
2. If zebra mussels are discovered, photograph and note approximate life stages.
3. Email the Water Quality Program Manager results of each station.
    a. Survey123 may be established as an alternate form of notification.

Veliger Stations

Targeted monitoring for dreissenid mussel veligers is typically conducted when water temperature is above 12°C. Sample stations for each reservoir are targeted around boat ramps, docks, and dam infrastructure. The number of tows at each station is based on the plankton net diameter and depth of each tow. A minimum total volume of 1000 liters per station should be filtered through the net. NAB utilizes a 30 cm (12 in) diameter net; to achieve 1000L, the total vertical tow(s) must equate to a minimum of 14.3 m (46.9 ft).

Example: A 30 cm net is used to collect 3 x 5-meter tows. All tows are dispensed into the sample collection bottle. 0.07m^2 (area of net mouth) x 15m x 1000L/m3 = 1050 liters of source water represented in the bottle

Collection procedure is as follows:

1. Set Up
    a. Prior to any water collection, label one 1L water bottle with standard information:
        i. Station
        ii. Date
        iii. Time
        iv. Depth
        v. Sample Type
    b. Fill out a COC Form
2. Collection
    a. Calculate the appropriate tow length for stations less than 14.3m (46.9 ft) deep.
        i. Determine the water depth utilizing a depth finder or marked rope.
        ii. Subtract, at least, the length of the plankton net plus 0.5m from the depth. This prevents the net from hitting the bottom of the waterbody, disturbing sediment, and fouling the sample.
        iii. Slowly lower the net to the appropriate depth.
        iv. Wait approximately 10 seconds for the net to settle.
            1. If the net hits bottom, raise it and thoroughly clean it before redoing the tow.
        v. Slowly pull the net up using a hand-over-hand motion, no faster than 0.5m/second. Raise the net until the opening is out of the water but the cod end

is still submerged. Keeping the opening out of the water, pulse the net up and down several times as you finish pulling it up.

vi. Remove the net from the water and carefully unscrew the cod end from the net without spilling any of the collected sample. You can concentrate the plankton sample by gently swirling the cod end and allowing some of the water to drain through the mesh. Pour the plankton sample into a leak-proof polyethylene bottle. Thoroughly rinse the cod end several times using a spray or squirt bottle filled with tap or DI water. Pour the rinse water from the cod end into the sample bottle. Be sure to rinse out the cod end after each tow.

vii. Repeat the vertical tow procedure to replicate samples at the sample location to achieve 1000L. All dreissenid veliger tows from the sample station can be composited. Be sure to allow adequate space in the sample for ethanol and baking soda solution if the sample is being preserved.

3. Sample Preservation and Storage
    a. Add 0.2g (0.2mL) of baking soda per every 100mL of sample.
    b. Add ethanol so that the preserved sample has at least 70% alcohol content.
        i. Measure the height of the collected sample and multiply by 3. The result of this calculation is the amount of alcohol that should be added to the sample. Place sample in cooler with ice.
    c. Pack all samples in a cooler with ice until they can be stored in a refrigerator.
4. Shipping
    a. Coordinate shipping to the appropriate lab as soon as possible. When preparing to ship, ensure all lids on the bottles are tight and there are no leaks. Utilize packing material to minimize bottle shifting during transport. Ensure the COC is placed in a plastic bag and into the shipping cooler.

Plate Stations

Targeted monitoring is typically conducted three to five weeks after water temperature is above 12°C and approximately two months after temperatures are no longer conducive to spawning. Due to scheduling constraints with the Water Quality Program and because biofilm takes approximately two months to develop on newly deployed devices, plates will typically be deployed in May and retrieved in October. The plates will be placed at 5’ below the surface, then every 10’ through 35’ as station depth allows. For example, if a station is 100’ deep, plates will be placed at 5’, 15’, 25’ and 35’; if a station is 20’ deep, the sets will be placed at 5’ and 15’ only. Typical reservoir elevation fluctuations between May and October need to be considered prior to placement; the buoy line must be long enough to account for rises, and the bottom/last plate set should be at a depth that will not touch bottom during drops.

Plate Assembly:

1. Pre-assembly Preparation
    a. Parts List to make one settlement plate set

Part	Size	Quantity
Zinc-Plated Eyebolt	1/2" × 10"	1
Square Rigid PVC Plates	6" × 6" × 1/8", 9/16" center hole	5
PVC Spacers	1/2" diameter, 15/16" length	5
Stainless Steel USS Flat Washers	1/2"	11
PVC Spacer	1/2" diameter, 13/16" length	1
Threaded Lifting Eye	1/2"-13	1
Zinc-Plated Lock Nut	1/2"-13	1
Spring Snaps	5/8"	2

    b. Tools Required
        i. 3/4" wrench (Box End)
        ii. Tape Measure
        iii. Chop Saw with Fine Tooth Blade
    c. Taking a 10' stock of 1/2" PVC pipe, using a measuring tape and marker, measure and mark:
        i. Five pieces at 15/16"
        ii. One piece at 13/16"
    d. Cut the PVC at the marked locations using a saw suitable for PVC.
    e. Deburr or sand the edges lightly to remove any sharp edges.
2. Assembly
    a. Prepare the Plates
        i. Place the PVC plates flat on a stable surface
        ii. Ensure the center holes are clear
    b. Insert the Eyebolt with Bottom Spacer
        i. Slide 1 × 15/16" PVC spacer (Part C) onto the eyebolt
        ii. Add 1 washer (Part D) on top of the spacer
    c. Insert Plate and Continue Stack
        i. Insert the eyebolt through the center hole of the first PVC plate (Part B)
            1. The spacer and washer now sit below the plate
        ii. Add 1 washer on top of the plate
    d. Build the Remaining Spacer Stack (Including Plates)

i. Continue stacking upward in this repeating order, making the plates part of the stack: 15/16" spacer → washer → plate → washer → 15/16" spacer → washer, until all remaining four PVC plates and four long spacers are used
ii. Ensure washers separate each spacer and plate

e. Install Final Spacer Section
    i. After the long spacers and plates are installed, add:
        1. 1 washer
        2. 1 shorter spacer (13/16")
        3. 1 washer
f. Install the Threading Lifting Eye
    i. Thread the lifting eye onto the shaft
    ii. Tighten until it sits firmly against the top washer
g. Secure with Lock Nut
    i. Thread the lock nut above the lifting eye
    ii. Tighten firmly using the 3/4" box-end wrench
h. Attach Spring Snaps
    i. Secure both spring snaps by attaching one to the eyebolt and the other to the lifting eye
i. Final Inspection Checklist
    i. All washers, spacers, and plates are aligned and evenly stacked
    ii. Eyebolt is centered
    iii. Lifting eye is tight and properly seated
    iv. Lock nut is secure
    v. Spring snaps function correctly

Collection procedure is as follows:

1. Deployment
    a. Prepare the system for deployment.
        i. Connect the anchor, line, plates, and buoy.
            1. Use spring snaps for quick connections, if needed.
            2. Diagrams are provided in USACE, 2026.b..
    b. Lower the designated system in at each station and ensure the line is long enough to account for seasonal elevation changes.
    c. Annotate the depth of each station and at what depths plate sets were placed.
2. Retrieval
    a. Prior to any collection, personnel will review documentation from the deployment and determine how many plate sets were placed. There will be one to four per station.
    b. Personnel will ensure there is a 5-gallon bucket per each plate set.
    c. Each bucket will be labeled with standard information:
        i. Station
        ii. Date
        iii. Time
        iv. Depth
        v. Station nickname for Ops personnel (e.g. campground name, bridge, boat launch)
    d. On the boat:

i. Slowly pull up the system to avoid losing attached organisms.
ii. Detach buoy and ropes from plate set.
iii. Place the plate set into the appropriately labeled bucket and place a lid on it.
iv. Keep samples cool and out of direct sunlight during transport to the processing site.

e. In a controlled environment (lab, dam office, etc.)
    i. Qualitative Analysis
        1. On a WQ Zebra Mussel Field Sheet
            a. Note the presence or absence of zebra mussels.
            b. Estimate percent coverage on each plate's surface.
            c. Measure the smallest and largest zebra mussels.
            d. Record dominant life stages.
            e. Note the presence of other organisms.
        2. Photograph the plates and ensure files are named with the station name, date, and depth (i.e. COW20002_20251028_5ft.jpg)

3. Analysis
    a. Quantitative
        i. Scrape each plate into a sieve
        ii. Use tap water to wash away and debris
        iii. Use forceps to sort out any biologicals that are not zebra mussels (snails, worms, other species of mussels)
        iv. If analyzing at a later time, complete the following steps:
            1. Using a pencil, fill out two labels that include the station, date, time, and depth. Place one label in the container and tape the other to the outside. Do not use a pen for labeling; ink will dissolve in ethanol.
            2. Submerge the sample in preservative, place the lid on the container, then gently swirl several times.
            3. Fill out the COC form.
        v. Determining Analysis Procedure
            1. Determine if subsampling is necessary. Enumerating the entire sample can sometimes be less time-consuming and always more accurate than subsampling.
                a. Perform a rough estimate of number of animals in the sample. This can be simply "eyeballing" if you have already counted similar samples, or if unsure, remove a portion of the sample, count the animals, and extrapolate. This initial estimate should not be time-consuming as it will only inform you of the need to subsample; this data should not be used for analyses.
                b. In general, samples estimated at less than ~5,000 animals should be completely enumerated.
                    i. However, when deciding whether to subsample, take into consideration the size of the animals. Samples consisting of mostly larger animals might be easier to count completely, while samples with a variety of sizes,

or lots of small animals can be more time-consuming and difficult to count and therefore should be subsampled.

2. Clean your sample as much as possible. This will end up saving time and improving accuracy. Cleaning methods include:
    a. Rinse the sample through fine micron sieves (~350 to 500-micron) to remove fine particulates.
    b. Drain off ethanol and fill with water to float off organic debris. Be cautious that there are no animals stuck in debris. Rinse and decant debris as needed.
    c. If mussels are entangled in debris, use fine forceps or a probe to hand-pick the sample. Use a stereomicroscope if needed to locate small mussels.
3. If the sample contains any residual liquid, decant as much as possible without losing any animals. Pour the contents of the vessel into a gridded pan. Use squirt bottle with ethanol to flush any remaining animals in the sample vessel.
4. Disperse the animals as evenly as possible across all cells of the pan. You can shake the pan horizontally or use a probe to help evenly distribute them.
5. Use a pipet to aspirate most of the remaining ethanol out of the pan so the animals are not floating/moving between cells. Use care to not remove animals when drawing up ethanol. Press the tip of a pipet firmly down on the surface of the pan, you can normally aspirate the liquid off without sucking up animals.
6. Use a random number generator to select the cell numbers you will sample.
    a. The appropriate number of cells to select and count depends on the number of animals in that sample and the number of cells in your gridded pan. With a 20-cell gridded pan, count a minimum of 4 cells, but more can be counted if animal numbers are low (i.e. less than 250 per cell).
    b. Example: If you estimate a sample to be between 5,000 and 20,000 newly settled dreissenid mussels, randomly select and enumerate 4 of the 20 cells (20%).
7. Use 2 single-edged razor blades to slide/scrape the contents of selected cells to the center of that cell. Use both razor blades in tandem to scoop them out of the cell and into a clean vessel containing 70% ethanol until they can be enumerated.
    a. This is not the only method for removing animals from grid cells. Other methods could work better depending on size of animals and characteristics of the sample.

vi. Enumeration

1. Set up stereomicroscope if small animals are present in your samples. If the animals are very small (< 1 mm), it is beneficial to utilize cross-polarization for ease of quickly identifying the animals by their

characteristic glowing shell. Be cautious not to confuse ostracods for dreissenid mussels as they have a similar look under cross polarization.

   a. If all the animals in a sample are large in size (> ~5 mm), the sample can be enumerated without a microscope (assuming there are not small animals attached to the large ones; it's best to verify this with a microscope).

2. Swirl and pour a portion of a sample into a gridded glass petri dish (plastic petri dishes become difficult to see through when using cross-polarization). You can also use a pipet with a wide-mouth tip to transfer small animals into the petri dish. Spread the sample out evenly in the gridded petri dish for ease of counting.
   a. If animals are large enough that you are not using a microscope, use a large flat pan for enumeration rather than gridded petri dishes. Use a metal probe to slide the animals into piles of known amounts (i.e. 50 or 100) as you count. Imagine a pharmacist counting pills.
   b. If the sample contains a lot of debris that cannot be removed, or it is very dense with animals, do not overload the petri dish. This will make accurate enumeration very difficult.
   c. Remember, sometimes a sample may look like all large animals but there are newly settled mussels attached to the large animals. If this is the case, you will need to utilize a dissecting scope for enumeration.
3. Use a tally counter to count each mussel in the petri dish. Use the gridded pattern of the petri dish to keep your position when counting each row or column.
   a. Use metal probes or fine forceps to tease apart debris mats that may be hiding animals.
4. After enumeration of the contents of the petri dish, rinse the sample into a clean vessel with ethanol squirt bottle. Ensure no animals are stuck in the petri dish before next filling next dish.
5. Record information on a WQ Zebra Mussel Field Sheet.
6. Repeat steps 1-5 until the entire sample or subsample has been enumerated.
   a. Field Sheets should include: whether or not you are subsampling, the number of cells being counted, number of animals counted in each cell, multiplier, and calculated total. If not subsampling, simply report total counted. Include any pertinent sample information.

Decontamination

Boat

1. Inspect
    a. Visually inspect the boat hull, motor, trailer, anchor, and live wells
    b. Remove and dispose of any visible plants, mussels, or mud
2. Drain
    a. Drain all water from bilge, live wells, ballast tanks, and motor before leaving the project
3. Clean
    a. Hot Water: Spray all exterior and interior surfaces with water ≥140 °F for at least 10 seconds per area
    b. Drying: allow boat and trailer to dry completely for at least five days in warm dry conditions before the next use.

Equipment

1. Rinse
    a. Rinse equipment with clean, pressurized water to remove debris and organisms
2. Soak or Spray
    a. Complete one of the following options:
        i. Hot Water: Soak or spray equipment with water ≥140 °F for at least 10 seconds per area
        ii. Bleach Solution: Soak in 10% household bleach for 10 minutes, then rinse thoroughly
        iii. Virkon Aquatic disinfectant per manufacturer instructions
3. Dry
    a. Air dry completely for at least five days before reuse in another waterbody

Quality Assurance/Quality Control Sampling

NAB is in process of developing a Water Quality Control Plan. This document will be updated once completed.

Citations

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U.S. Army Corps of Engineers. (2026.a). *Water Quality Program Management Plan.* Engineering Division, Civil Works Branch.

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Appendix A: NAB Water Quality Field Sheet

U.S. ARMY CORPS OF ENGINEERS, BALTIMORE DISTRICT

WATER QUALITY FIELD SHEET

PROJECT:	PERSONNEL:	
STATION:	DATE (YYYYMMDD):	TIME (HHMM):
WEATHER:	WIND VELOCITY (mph):	
WATER COLOR/APPEARANCE:	SONDE ID:	
REMARKS:		

MAXIMUM DEPTH (feet):	SECCHI DISK (m):	WATER SURFACE ELEVATION (feet):	REMARKS:

READINGS

DEPTH (feet)	WATER TEMPERATURE (°C)	DISSOLVED OXYGEN (mg/L)	DISSOLVED OXYGEN (% Sat)	SPECIFIC COND. (umho/cm)	pH (units)	ORP (mV)	TOTAL ALKALINITY (mg/L)	P-ALK (mg/L)	ACIDITY (mg/L)
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Appendix B: NAB Water Quality Zebra Mussel Field Sheet

Shoreline Survey		
PROJECT:	PERSONNEL:	
STATION NICKNAME:	COLLECTION DATE (YYYYMMDD):	TIME (HHMM):
WEATHER:		
LAT/LONG (dec. deg.):		
DOMINANT LIFESTAGE: % SURFACE COVER:	REMARKS:	

Note: Take photos and submit to NAB-Water Quality mailbox (NAB-Water-Quality@usace.army.mil)

Veliger Survey		
PROJECT:	PERSONNEL:	
STATION:	COLLECTION DATE (YYYYMMDD):	TIME (HHMM):
WEATHER:	ANALYSIS COMPLETED BY:	

COLLECTION DEPTH (feet)	COUNT	REMARKS:

Note: Take photos and submit to NAB-Water Quality mailbox (NAB-Water-Quality@usace.army.mil)

Settlement Plate Survey		
PROJECT:	PERSONNEL:	
STATION:	COLLECTION DATE (YYYYMMDD):	TIME (HHMM):
ANALYSIS DATE:	ANALYSIS COMPLETED BY:	

DEPTH (feet)	% PLATE COVER	MIN SIZE (cm)	MAX SIZE (cm)	DOMINANT LIFESTAGE	COUNT	REMARKS:
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Note: Take photos and submit to NAB-Water Quality mailbox (NAB-Water-Quality@usace.army.mil)

Appendix C: Chain of Custody

BSA ENVIRONMENTAL SERVICES, INC.

BSA Environmental Services, Inc.
23400 Mercantile Rd., Suite 8
Beachwood, OH 44122
P: 216-765-0582 F: 216-765-0583
Email: j.beaver@bsaenv.com

CHAIN OF CUSTODY

Client Information	Invoice Information
Client Name: U.S. Army Corps of Engineers, Baltimore District	Invoice To: Kayley Laber
Address: 2 Hopkins Plaza	Address: 3909 Halls Ferry Rd, Bldg 3270, Rm 2122
City: Baltimore State: MD Zip:21201	City: Vicksburg State: MS Zip: 39180
Contact: Sarah Pedrick	Contact: Kayley Laber
Phone Number: 443-931-1707 Fax Number: N/A	Phone Number: 601-634-3835 Fax Number: N/A
Email: sarah.d.pedrick@usace.army.mil	Email: Kayley.C.Laber@erdc.dren.mil

Project Name: Almond
Project Number: N/A
Special Instructions:

	Sample ID/Number	Site Name	Sample Date	Sample Time	Analysis Requested	Other Sample Information
1					Invert ID	NYSDEC
2					Invert ID	NYSDEC
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Relinquished By:	Date:	Time:	Received By:	Date:	Time:
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Relinquished By:	Date:	Time:	Received By:	Date:	Time:

COMMENTS: Contract #

Appendix D: Water Quality Parameters

In situ	**Water Chemistry**	**Biological**
• Water Temperature • Dissolved Oxygen • Specific Conductance • pH • Secchi Disk	• Acidity, Total • Alkalinity, Total and Phenolphthalein • Aluminum, Total • Ammonia, Total • Calcium, Total • Iron, Total • Manganese, Total • Mercury, Total • Nitrate + Nitrite • Nitrogen, Total • Orthophosphate, Dissolved • Phosphorus, Total • Sulfate, Total	• Benthic Macroinvertebrates • Chlorophyll a • Phytoplankton • Zebra Mussels

Appendix E: Habitat Assessment Field Sheet

HABITAT ASSESSMENT FIELD SHEET- MODERATE TO HIGH GRADIENT STREAMS (FRONT)
(See Protocol E for detailed descriptions and rank information)

DWR Station ID:		**Habitat Assessment By:**	
Monitoring Location Name:		**Date:**	**Time:**
Monitoring Location:		**Field Log Number:**	
HUC:	WS Group:	Ecoregion:	QC: ☐ Duplicate ☐ Consensus

	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Epifaunal Substrate/ Available Cover	Over 70% of stream reach has natural stable habitat suitable for colonization by fish and/or macroinvertebrates. Four or more productive habitats are present.	Natural stable habitat covers 40-70% of stream reach. Three or more productive habitats present. (If near 70% and more than 3 go to optimal.)	Natural stable habitat covers 20 -40% of stream reach or only 1-2 productive habitats present. (If near 40% and more than 2 go to suboptimal.)	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
2.Embeddedness of Riffles	Gravel, cobble, and boulders 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space. If near 25% drop to suboptimal if riffle not layered cobble.	Gravel, cobble and boulders 25-50% surrounded by fine sediment. Niches in bottom layers of cobble compromised. If near 50% & riffles not layered cobble drop to marginal.	Gravel, cobble, and boulder s are 50-75% surrounded by fine sediment. Niche space in middle layers of cobble is starting to fill with fine sediment.	Gravel, cobble, and boulders are more than 75% surrounded by fine sediment. Niche space is reduced to a single layer or is absent.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
3. Velocity/ Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow).	Only 3 of the 4 regimes present (if fast-shallow is missing score lower). If slow-deep missing score 15.	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/depth regime. Others regimes too small or infrequent to support aquatic populations.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
4. Sediment Deposition	Sediment deposition affects less than 5% of stream bottom in quiet areas. New deposition on islands and point bars is absent or minimal.	Sediment deposition affects 5-30% of stream bottom. Slight deposition in pool or slow areas. Some new deposition on islands and point bars. Move to marginal if build-up approaches 30%.	Sediment deposition affects 30-50% of stream bottom. Sediment deposits at obstruction, constrictions and bends. Moderate pool deposition.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
5. Channel Flow Status. .	Water reaches base of both lower banks and streambed is covered by water throughout reach. Minimal productive habitat is exposed.	Water covers > 75% of streambed or 25% of productive habitat is exposed.	Water covers 25-75% of streambed and/or productive habitat is mostly exposed.	Very little water in channel and mostly present as standing pools. Little or no productive habitat due to lack of water.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				

HABITAT ASSESSMENT FIELD SHEET- MODERATE TO HIGH GRADIENT STREAMS (BACK)

DWR Station ID_____ Date_____ Assessors_____

	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization, dredging rock removal or 4-wheel activity (past or present) absent or minimal; natural meander pattern. NO artificial structures in reach. Upstream or downstream structures do not affect reach.	Channelization, dredging or 4-wheel activity up to 40%. Channel has stabilized. If larger reach, channelization is historic and stable. Artificial structures in or out of reach do not affect natural flow patterns.	Channelization, dredging or 4-wheel activity 40-80% (or less that has not stabilized.) Artificial structures in or out of reach may have slight affect.	Over 80% of reach channelized, dredged or affected by 4-wheelers. Instream habitat greatly altered or removed. Artificial structures have greatly affected flow pattern.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
7. Frequency of re-oxygenation zones. Use frequency of riffle or bends for category. Rank by quality.	Occurrence of re-oxygenation zones relatively frequent; ratio of distance between areas divided by average stream width <7:1.	Occurrence of re-oxygenation zones infrequent; distance between areas divided by average stream width is 7 - 15.	Occasional re-oxygenation area. The distance between areas divided by average stream width is over 15 and up to 25.	Generally all flat water or flat bedrock; little opportunity for re-oxygenation. Distance between areas divided by average stream width >25.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
8. Bank Stability (score each bank) Determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion. If approaching 30% score marginal if banks steep.	Moderately unstable; 30-60 % of bank in reach has areas of erosion; high erosion potential during floods, If approaching 60% score poor if banks steep.	Unstable; many eroded area; raw areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE___(LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE___(RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
Comments				
9. Vegetative Protective (score each bank) includes vegetation from top of bank to base of bank. Determine left or right side by facing downstream	More than 90% of the bank covered by undisturbed vegetation. All 4 classes (mature trees, understory trees, shrubs, groundcover) are represented and allowed to grow naturally. All plants are native.	70-90% of the bank covered by undisturbed vegetation. One class may not be well represented. Disruption evident but not effecting full plant growth. Non-natives are rare (< 30%)	50-70% of the bank covered by undisturbed vegetation. Two classes of vegetation may not be well represented. Non-native vegetation may be common (30-50%).	Less than 50% of the bank covered by undisturbed vegetation or more than 2 classes are not well represented or most vegetation has been cropped. Non-native vegetation may dominate (> 50%)
SCORE___(LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE___(RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
Comments				
10. Riparian Vegetative Zone Width (score each bank.) Zone begins at top of bank.	Average width of riparian zone > 18 meters. Unpaved footpaths may score 9 if run-off potential is negligible.	Average width of riparian zone 12-18 meters. Score high if areas < 18 meters are small or are minimally disturbed.	Average width of riparian zone 6-11 meters. Score high if areas less than 12 meters are small or are minimally disturbed.	Average width of riparian zone <6 meters. Score high if areas less than 6 meters are small or are minimally disturbed.
SCORE___(LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE___(RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
Comments				

Total Score _____ Comparison to Ecoregion Guidelines (circle): ABOVE or BELOW
If score is below guidelines , result of (circle): Natural Conditions or Human Disturbance
Describe:

HABITAT ASSESSMENT FIELD SHEET- LOW GRADIENT STREAMS (FRONT)
(Revised 06-09-17 – See Protocol E for detailed description and rank information)

DWR Station ID:		**Habitat Assessment By:**	
Monitoring Location Name:		**Date:**	**Time:**
Monitoring Location:		**Field Log Number:**	
HUC:	WS Group:	Ecoregion:	QC: ☐ Duplicate ☐ Consensus

	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Epifaunal Substrate/ Available Cover	Over 50% of reach has natural, stable habitat for colonization by macroinvertebrates and/or fish. Three or more productive habitats are present.	Natural stable habitat covers 30-50% of stream reach or less than three habitats are present.	Natural stable habitat 10-30% of stream reach. Availability less than desirable, substrate frequently disturbed or removed. Habitat diversity is reduced.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
2. Channel Substrate Characterization	Good mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud or clay; or substrate is fissured bedrock, some root mats and submerged vegetation present.	All mud, clay, soft sand or fissured bedrock bottom, little or no root mat, no submerged vegetation present.	Hard-pan clay, conglomerate or predominantly flat bedrock; no root mat or submerged vegetation.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools are large-deep very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
4. Sediment Deposition	Sediment deposition affects less than 20% of stream bottom in quiet areas. New deposition on islands and point bars is absent or minimal.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 20-50% of bottom affected. Slight deposition in pools.	Moderate deposition of fine material on old and new bars, 50-80% of bottom affected; sediment deposits at obstructions, constrictions and bends; moderate deposition of pools.	Heavy deposits of fine material, increased bar development; more than 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
5. Channel Flow Status. If water backed up by obstructions (beaver dam, log jams, bedrock during low flow) move assessment reach above or below affected area or consider postponing sampling until accurate assessment of stream can be achieved.	Water reaches base of both lower banks throughout reach. Streambed is covered. Minimal productive habitat is exposed.	Water covers > 75% of streambed and/or < 25% of productive habitat is exposed.	Water covers 25-75% of streambed and/or stable habitat is mostly exposed.	Very little water in channel and mostly present as standing pools. Little or no productive habitat due to lack of water.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				

HABITAT ASSESSMENT FIELD SHEET- LOW GRADIENT STREAMS (BACK)

DWR Station ID_____ Date_____ Assessor:_____

	Optimal	**Suboptimal**	**Marginal**	**Poor**
6. Channel Alteration	Channelization, dredging or 4-wheel activity absent or minimal; natural meander pattern. NO artificial structures in reach. Upstream or downstream structures do not affect reach.	Channelization, dredging or 4-wheel activity up to 40%. Channel has stabilized. If larger reach, channelization is historic and stable. Artificial structures in or out of reach do not affect natural flow patterns.	Channelization, dredging or 4-wheel activity 40-80% (or less that has not stabilized.) Artificial structures in or out of reach may have slight affect.	Over 80% of reach channelized, dredged or affected by 4-wheelers. Instream habitat greatly altered or removed. Artificial structures may have greatly affected flow pattern.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
7. Channel Sinuosity (Entire meander sequence not limited to sampling reach)	The bends in the stream increase the stream length 3-4 times longer than if it was in a straight line.	The bends in the stream increase the stream length 2-3 times longer than if it was in a straight line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
8. Bank Stability (score each bank) Determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems <5% of bank affected.	Moderately stable; infrequent, small areas of erosion 5-30% of bank eroded. If approaching 30% score marginal if banks steep.	Moderately unstable; 30-60 % of bank in reach has areas of erosion; high erosion potential during floods, If approaching 60% score poor if banks steep.	Unstable; many eroded area; raw areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE___(LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE___(RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
Comments				
9. Vegetative Protective (score each bank) includes vegetation from top of bank to base of bank. Determine left or right side by facing downstream	More than 90% of the bank covered by undisturbed vegetation. All 4 classes (mature trees, understory trees, shrubs, groundcover) are represented and allowed to grow naturally. All plants are native.	70-90% of the bank covered by undisturbed vegetation. One class may not be well represented. Disruption evident but not effecting full plant growth. Non-natives are rare (< 30%)	50-70% of the bank covered by undisturbed vegetation. Two classes of vegetation may not be well represented. Non-native vegetation may be common (30-50%).	Less than 50% of the bank covered by undisturbed vegetation or more than 2 classes are not well represented or most vegetation has been cropped. Non-native vegetation may dominate (> 50%)
SCORE___(LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE___(RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
Comments				
10. Riparian Vegetative Zone Width (score each bank.) Zone begins at top of bank.	Average width of riparian zone > 18 meters. Unpaved footpaths may score 9 if run-off potential is negligible.	Average width of riparian zone 12-18 meters. Score high if areas < 18 meters are small or are minimally disturbed.	Average width of riparian zone 6-11 meters. Score high if areas less than 12 meters are small or are minimally disturbed.	Average width of riparian zone <6 meters. Score high if areas less than 6 meters are small or are minimally disturbed.
SCORE___(LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE___(RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
Comments				

Total Score _____ Comparison to Ecoregion Guidelines (circle): ABOVE or BELOW

If score below guidelines, result of (circle): Natural Conditions or Human Disturbance

Describe